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Study of Corrosion Protection Systems on Zinc and Iron Using Particle Deposition Initiation

A. Neufeld (CSIRO, Australia), H. Isaacs (BNL), A. Bond (Monash University), S. Furman (CSIRO Australia), and I. Cole (CSIRO Australia)

Beamline(s): X26A

Introduction: Monitoring the corrosion process on zinc has been undertaken by Neufeld et al. [1] where a scanning Kelvin probe was used to show the potential distributions over the area in which the corrosion initiation has occurred. In addition, initial studies using Synchrotron generated X-Ray fluorescence mapping have shown that indeed the specific transport of cations into the region affected by “secondary spreading” corresponded to cathodic regions as determined by the potential mapping. New work on X26A has assisted in understanding how inhibitors affect the secondary spreading process on zinc, and how corrosion initiation on other metals such as iron and aluminium are affected by the secondary spreading process

Methods and Materials: Using a micro-syringe, a droplet of approximately 0.2 microliters was placed on the surface of polished high purity zinc, iron and aluminium alloy 2024-T3. Rubidium and Bromine were used as indicators for the lighter elements sodium and chloride respectively. Inhibitors investigated in the 1M NaCl solutions were salts of dichromate, manganate, and tungstate. The metal specimens were mounted in a Perspex chamber which was sealed using a Mylar film. This chamber was mounted on a stepper motor driven translation system to enable mapping. The X-Ray beam had a spot size of approximately 30 microns in diameter and during mapping step sizes between 25 and 50 microns were used, collecting the fluorescence signal from between 2 and 4 seconds livetime.

Results: Corrosion initiation experiments performed on iron and aluminium resulted in a distribution of micron sized droplets containing Rubidium. The absence of Bromine suggests that this distribution of micron sized droplets which becomes larger over time is the result of a secondary spreading process, as with zinc. The most significant difference between zinc and iron is that a continuous film cannot be visibly detected. The effect of inhibitors with a ratio to chloride concentration in the range of 1:100-1000 on zinc corrosion initiation was an initial increase in the rate of secondary spreading and then a cessation of the film growth much sooner than is the case without inhibitor. It was not until the ratio of dichromate to chloride was increased to 1:10 that the secondary spreading process was totally inhibited. The effect of tungstate on iron was less clear, since the observation of the secondary spreading process was much more difficult to detect. However, mapping of tungsten within the droplet in the region where corrosion products were visible. Illustrated in figure 1 is a contour map showing the intensity of tungsten on a region of the iron surface which is covered by a droplet of sodium chloride solution. It is clear from this map that the tungstate anions must be forming a specific complex with iron ions which are the result of oxidation of the iron surface.

Conclusions: The secondary spreading process is not exclusive to zinc metal, as it has now been observed on iron and aluminium, and hence is intrinsically linked with metal oxidation. Under the conditions of corrosion initiation by microdroplets, the mechanism of corrosion inhibition at low inhibitor concentration may involve the initial reduction of the inhibitor species and subsequent reaction with active areas of metal oxidation

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References: [1] A. K. Neufeld, I.S. Cole, A. M. Bond, S. Furman, “The Initiation Mechanism of Corrosion of Zinc by Sodium Chloride Particle Deposition”. In Press Corrosion Science 2002.

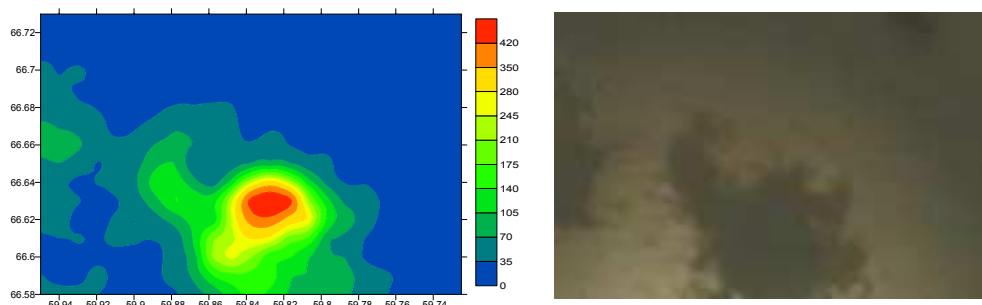


Figure 1: Contour Map of Tungsten intensity (left) and an image of the map area showing the localized formation of corrosion product (right).